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LEVEL II

3

USAF/ASEE SUMMER FACULTY PROGRAM
RESEARCH ON DESIGN ANALYSIS FOR DUAL-MODE AIR-LAUNCHED MISSILE SYSTEM

December 1978

Final Technical Report
AFOSR Contract No. F49620-78-C-0011

for

Air Force Office of Scientific Research
Bolling Air Force Base, DC 20332

UNIVERSITY OF DAYTON
School of Engineering
DAYTON, OHIO

Unclassified

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report represents the results of an analysis of the major technical aspects of the advanced strategic air launched missile (ASALM) system concept as developed independently by two aerospace contractors, McDonnell Douglas Aerospace Corporation and Martin Marietta Corporation for the U.S. Air Force. This effort was assigned to selected members of the ASEE (American Society for Engineering Education) and conducted under the Summer Faculty Program from June through the first week of August 1978. The objectives of this study were to:

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20. Abstract (continued)

provide the Air Force with an independent assessment of the technical risks associated with the major system and sub-systems of an Advanced Strategic Air Launched Missile (ASALM); identification and analysis of critical ASALM performance parameters which offset overall system effectiveness, and identification of system design tradeoffs in high technical risk areas which would optimize overall system effectiveness.

The Study Group investigated the major subsystems area from the viewpoint of a totally integrated weapon system in order to assess the system performance, identify critical problem areas and identify major discrepancies in the estimation of the life cycle cost. Basically the value of this effort is established in the reinforcement of the importance of those critical technology and performance factors which could delay the progress or degrade the performance of the proposed weapon system. Thus the data and comments reported as a result of this investigation will assist in the formulation of criteria for the selection of a final Advanced Air Launched Strategic System.

LEVEL II

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UDSE-TR-78-13-Vol. I

USAF/ASEE SUMMER FACULTY PROGRAM
RESEARCH ON DESIGN ANALYSIS FOR DUAL-MODE AIR-LAUNCHED MISSILE SYSTEM

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ABSTRACT

This report represents the results of an analysis of the major technical aspects of the advanced strategic air launched missile system concept as developed independently by two aerospace contractors, McDonnell Douglas Aerospace Corporation and Martin Marietta Corporation for the U.S. Air Force. This effort was assigned to selected members of the ASEE (American Society for Engineering Education) and conducted under the Summer Faculty Program from June through the first week of August 1978. The objectives of this study were to: provide the Air Force with an independent assessment of the technical risks associated with the major system and subsystems of an Advanced Strategic Air Launched Missile (ASALM), identification and analysis of critical ASALM performance parameters which offset overall system effectiveness, and identification of system design tradeoffs in high technical risk areas which would optimize overall system effectiveness.

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TABLE OF CONTENTS

SECTION 1
INTRODUCTION

Early pre-study discussions between representatives of the School of Engineering of the University of Dayton confirmed the desirability of a Summer Faculty Design Study, concentrating in the area of air-launched cruise missiles. The financial support of USAF being assured, negotiations were begun with the appropriate groups at Wright-Patterson Air Force Base (WPAFB), to ascertain the set of problems most likely to benefit from a short-term study conducted by a group from academe.

The candidate missiles were determined to be:

- SRAM-L, a physically larger version of the SRAM currently in production
- ALCM, a system worthy of consideration, but at a point in its evolution that would make it difficult to investigate because of a competitive evaluation underway
- ASALM, a system with a reasonably remote IOC, and an abundance of technical information readily available
- STALWART, a revolutionary (as opposed to evolutionary) system which would not allow for the desired degree of interaction between the Study Group and their professional peers in the Air Force.

During the initial phases of the Design Study, it was hoped that engineering comparison of these various systems and their mission roles could be performed. However, by the conclusion of the first Steering Committee meeting on July 7, 1978, it was clear to all involved that the appropriate information for a responsible comparison was not available. Thus, the group opted to concentrate on the ASALM system, and that decision is reflected in all that follows.

SECTION 2

STATEMENT OF WORK

After considerable pre-study deliberation, the proposed Statement of Work contained in the following two pages was approved and adopted prior to the start of the program.

As noted previously, after the Study Group assembled and began their deliberations it became obvious that the work was proceeding in accordance with the interests and skills of the group members, because this highly-motivated group was attempting to produce the best possible output in the limited time available. Since the proposed Statement of Work was advisory in nature, this course of action was entirely appropriate.

Thus, the actual activities of the Study Group are detailed in Volume II, and cannot be reduced to a simple description.

It is important to note that the proposed Statement of Work served as a valuable starting point for the Study Group during the initial phase of its activities; it is included here for that reason.

ASEE/USAF SUMMER FACULTY PROGRAM

RESEARCH ON DESIGN ANALYSIS FOR DUAL MODE AIR LAUNCHED MISSILE SYSTEM

Proposed Statement of Work

1. Introduction

Air Force sponsored studies have shown that an advanced air-launched missile capable of performing the multi-mission role of air-to-air and air-to-ground defense suppression and prime strike is an attractive system capability option of the U.S. strategic forces in the mid 1980 time period. As a result, the Air Force has conducted numerous conceptual design studies based upon a projected threat definition. A number of advanced development programs have been established, and are in progress, which support the ASALM concept. These efforts were defined to meet an operational capability in the 1987 time period. Recent events have dictated that an ASALM type system should be readied for entry into the strategic force in 1985. This accelerated schedule may require system trade-offs which could result in less capability than previously anticipated for ASALM.

2. Study Objectives

a. Provide the Air Force with a thorough independent technical comparison of all known design alternatives to the ASALM mission.

b. Provide the Air Force with an independent assessment of the technical risks associated with each of these alternatives.

c. Identification and analysis of all critical ASALM performance parameters which affect overall system effectiveness.

d. Identification of system design trade-offs in high technical risk areas which would optimize overall system effectiveness.

3. Summary of Work to be Accomplished

a. The investigator will assess the importance of missile characteristics, such as speed, RCS and range, relative to its ability to survive and perform its intended missions.

b. Based on this evaluation, the investigator will conduct sufficient mission analysis to establish minimum system requirements for a Multi-Mission Missile System. Current systems and projected concepts (to be identified by the Air Force) which might be considered for strategic roles will be evaluated against these requirements and compared with each other. The comparison shall include determination of development risk and measures of system effectiveness.

c. Identify and evaluate alternate subsystem concepts which could more effectively satisfy the ASALM requirements.

4. Summary

The results and conclusions of this study will provide an overall assessment and comparison of current and projected strategic systems. The ASALM concept, as well as alternative concepts, will be included in this comparison. Emphasis will be placed on risk assessment and identification of major technical challenges for each system considered.

SECTION 3

STEERING COMMITTEE

With the concurrence and participation of all involved groups, a Steering Committee was selected for the purpose of providing guidance and support for the group during the study. The people listed below were on the Steering Committee.

Col. J. H. Eibling (Chairman)
ASD/YYX
Wright-Patterson AFB, Ohio 45433

Mr. John Chuprun
ASD/XRH
Wright-Patterson AFB, Ohio 45433

Lt. Col. Leland Nicolai
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1400 Wilson Blvd.
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Mr. Art Thomas
OASA(DRA)
Department of Defense
3E379 Pentagon
Washington, D. C. 20330

Mr. Denny White
ASD/ENO
Wright-Patterson AFB, Ohio 45433

This Steering Committee met twice during the study, conducting a thorough review of the Study Group activities and findings on both occasions.

SECTION 4

THE STUDY GROUP

Listed below are the sixteen people most intimately connected with the study.

Dr. Jay D. Pinson
Program Director

Dr. Donald E. Lewis
Assistant Program Director

Mr. Fred Orazio
Technical Director

Mrs. Sandy Fusek
Administrative Assistant

Dr. F. Gerard Albers
University of Dayton
Ph.D., Electrical Engineering

Dr. Albert W. Biggs
University of Kansas
Ph.D., Electrical Engineering

Dr. John N. Crisp
University of Dayton
Ph.D., Mechanical Engineering

Dr. Thomas C. Evans, Jr.
The Citadel
Ph.D., Engineering Mechanics

Dr. Elayne A. Idowu
University of Pittsburgh
Ph.D., Mathematics

Dr. Leo R. Maier, Jr.
Ohio Northern University
Ph.D., Engineering Mechanics

Dr. James Otis Nichols
Auburn University
Ph.D., Engineering Mechanics

Dr. Thomas Conley Powell
University of Tennessee Space Institute
Ph.D., Mechanical Engineering

Dr. Charles L. Proctor
Western Michigan University
Ph.D., Industrial Engineering

Dr. Delbert E. Robison
California State University
Ph.D., Mechanical Engineering

Dr. George H. Stickney
University of Missouri-Columbia
Ph.D., Engineering Management

Dr. John Zickel
California State University
Ph.D., Applied Mechanics

The members of the Study Group were divided into special-interest technical groups at the beginning of the second week of the study, in order to facilitate interactions with various USAF organizations, and to encourage meaningful findings. The technical groups were as follows:

Performance

Dr. Thomas E. Evans, Jr.
Dr. James Otis Nichols
Dr. Thomas Conley Powell
Dr. George H. Stickney
Dr. John Zickel

Propulsion

Dr. Thomas Conley Powell
Dr. Delbert E. Robison

Avionics

Dr. F. Gerard Albers
Dr. Albert W. Biggs
Dr. Donald E. Lewis

Power Requirements

Dr. John N. Crisp
Dr. Leo R. Maier, Jr.

Survivability

Dr. Charles L. Proctor

Cost

Dr. Elayne A. Idowu

SECTION 5

THE FIRST WEEK BRIEFINGS

The schedule below summarizes the briefings arranged for the Study Group during the first week of the program. The briefings were primarily concentrated on the research activities related to Dual-Mode Air Launched Missile System.

AFAL

AFAPL

AFRPL

AFFD

AFML

ASD/YYM

ASD/YYMA

ASD/YYX

CSD

Marquardt (RJ & FVPS)

Martin Marietta (PTV)

McDonnell Douglas

Raytheon

Rockwell

SAC

Thiokol

SECTION 6
AN INTRODUCTION TO VOLUME II

This Executive Summary has been specifically prepared as an unclassified document for those wishing to acquaint themselves with the administrative and technical details of conducting a Summer Faculty Program for Research in Engineering Systems Design.

The main work of the faculty participants in the Study Group is contained in Volume II, a classified document. It is our intention that the final report will be disseminated in only two forms, namely;

1. The combination of Volumes I and II for those with appropriate clearance and need-to-know, and
2. Volume I alone, for those wishing administrative information on the program only.

Volume II consists of an introductory chapter by Mr. Fred Orazio, Technical Director of the Summer Study, which addresses the ASALM design philosophy, and the strategic environment in which it will function. This work forms the background against which the remaining chapters must be evaluated.

Each technical group, under the guidance of its Group Leader has cooperatively written a chapter of Volume II, with only minimum interference by the study "management". Thus, each "chapter" reflects the opinion and/or mind-set of the responsible group. Those matters which seem, to the group, deserving of consideration, are covered to the extent that the available information allows. If the reader feels that significant factors are not mentioned, or adequately treated, it is because the data presented to the group did not allow them to reach a definitive conclusion regarding that factor. Figures, data, and graphs have been taken from existing reports, generally without explicit permission of the originating

organization, in the construction of Volume II. While not an accepted academic practice, in general, this technique is essential in the conclusion of a Systems Design Study within a reasonable time.

The concentrated period of interaction with USAF personnel has resulted in the writing of Volume II in the vernacular of the System Project Office, as opposed to the familiar campus language; the mixture of these modes of expression can only benefit both.

Finally, Volume II has been written with no experimentation by the groups, and with only a minimum of analysis to confirm the data obtained. The ten-week duration of the design study precluded the addition of significant originality by the faculty participants. Since many of our students will be called upon to function under identical conditions, this necessity has been a valuable learning experience for us.

The findings presented in Volume II were not constrained or dictated in any way. They reflect the best efforts of the faculty participants and, generally, agreement within a special-interest technical group. The report is meant to stand on its own as the result of a short-term effort by a group of dedicated professionals.